UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	ELECTRICAL POWER QUALITY
COURSE CODE	:	MEK 10403
PROGRAMME CODE	:	MEE
EXAMINATION DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS **CLOSED BOOK EXAMINATION**

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Discuss any **TWO (2)** causes of harmonic voltage distortion.

(2 marks)

(b) A distribution company operates 7500 distribution transformers. Over a period of 10 years, 140 of these transformers fail for various reasons. A small fraction of them can be repaired, but most failures require replacement with a spare transformer. Records have been kept of the repair or replacement time needed. Adding all these for the 140 failures gives a total of 7360 hours. With the help of reliability evaluation quantities descriptions and their respective equations, evaluate:

(i) Expected time to repair 'R'.

(2 marks)

(ii) Failure rate 'λ'.

(2 marks)

(iii) The expected time to failure 'T'.

(2 marks)

(iv) The repair rate 'μ'.

(2 marks)

(v) The availability of the component 'P'.

(2 marks)

(vi) The unavailability of the component 'Q'.

(2 marks)

(c) **Figure Q1(c)** shows a network elements. The individual outage/failure rates λ_n and repair times r_n are given below:

$\lambda_1 = 1, \quad \lambda_2 = 2, \quad \lambda_3 = 0.5, \quad \lambda_4 = 0.8, \quad \lambda_5 = 1.5$

$r_1 = 0.2, \quad r_2 = 0.1, \quad r_3 = 0.1, \quad r_4 = 0.15, \quad r_5 = 0.2$

Estimate the failure rate λ and repair time r of the whole system.

(11 marks)

Q2 (a) Discuss the significance of the K-factor of the transformer. Support it with proper standard/code and proper equations.

(3 marks)

(b) Suppose a short interruption occurs due to lightning on an overhead distribution network as shown in **Figure Q2(b)**. Analyse the behaviour of voltage, induction and synchronous

motor loads and induction and synchronous generators along with protection towards the short interruption incident.

(10 marks)

(c) (i) Criticise at least **FOUR (4)** sources of voltage drop in distribution system.

(2 marks)

(ii) Compose the $\%V_{drop}$ value at the Main Distribution Panel (MDP) for the system shown in **Figure Q2(c)**.

(10 marks)

Q3 (a) **Figure Q3(a)** shows the plot of the voltage trend based on the following equation.

$$v(t) = 2\cos(\omega t) - 2.5\cos\left(3\omega t - \frac{\pi}{5}\right) + 4\cos\left(5\omega t + \frac{\pi}{7}\right) + 2cos\left(7\omega t - \frac{\pi}{9}\right)$$

Calculate the crest factor of this voltage.

(4 marks)

(b) Explain the purpose of power quality survey.

(8 marks)

(c) Plan a power quality survey framework for a voltage sag end-user side power quality problem.

(13 marks)

Q4 (a) Explain the benefits of determining the cost-effectiveness of power quality improvement to both end-user and utility side.

(5 marks)

(b) Differentiate the power quality value-based economic analysis between the end-user perspective and utility perspective.

(6 marks)

(c) Devise steps for power quality improvement cost for the following:

(i) Harmonic mitigation cost.

(7 marks)

(ii) Flicker elimination cost.

(7 marks)

– END OF QUESTIONS–

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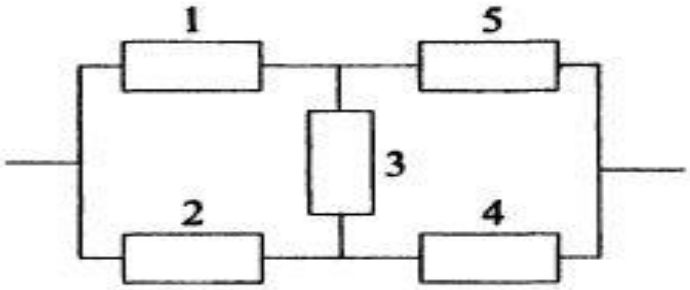

Figure Q1(c): A network element

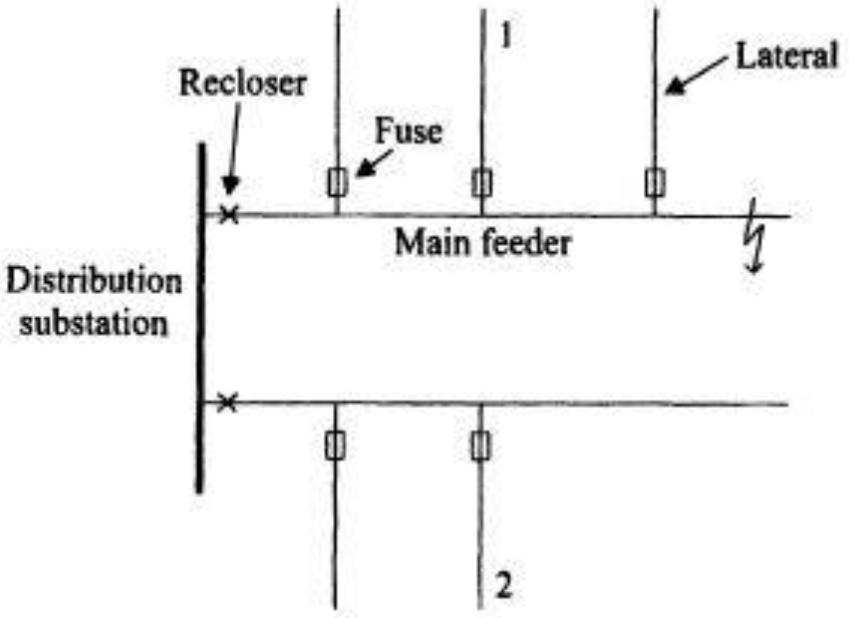

Figure Q2(b): An overhead distribution network

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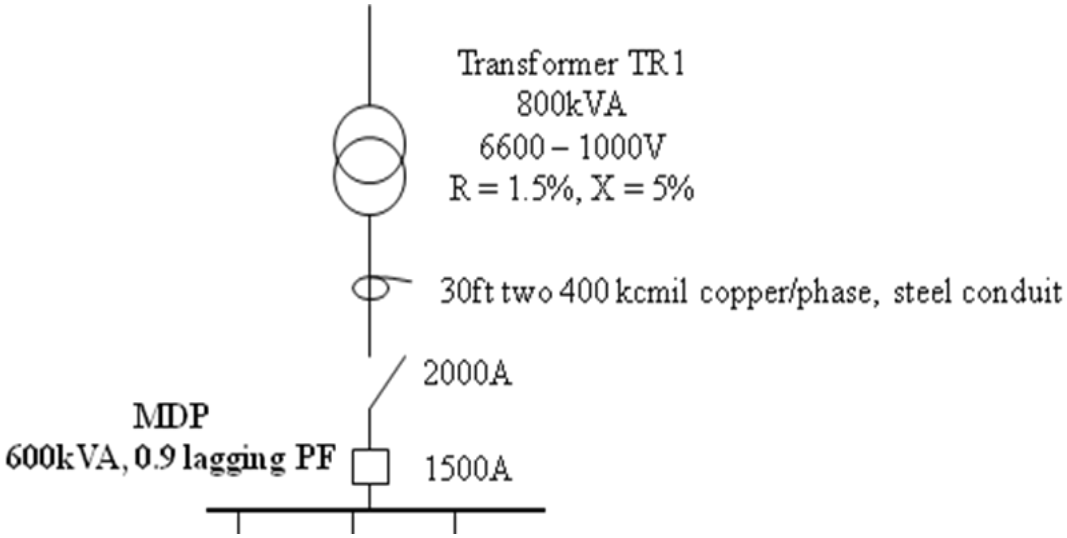

Figure Q2(c): A system

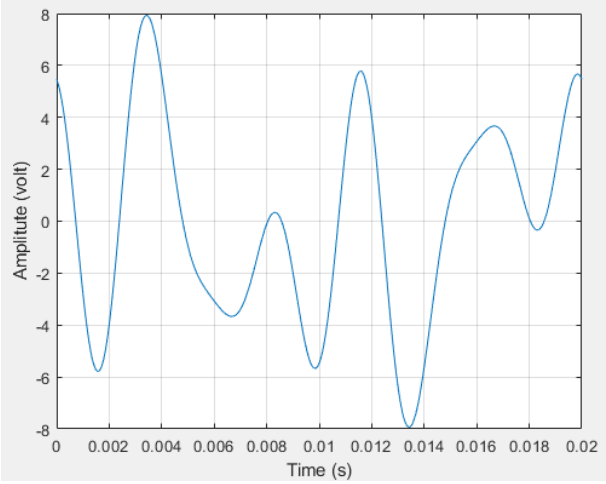

Figure Q3(a): Plot of voltage vs time